

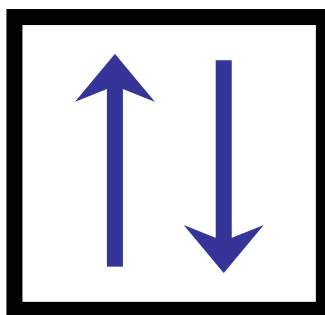


# General Rules



Wolfgang Pauli

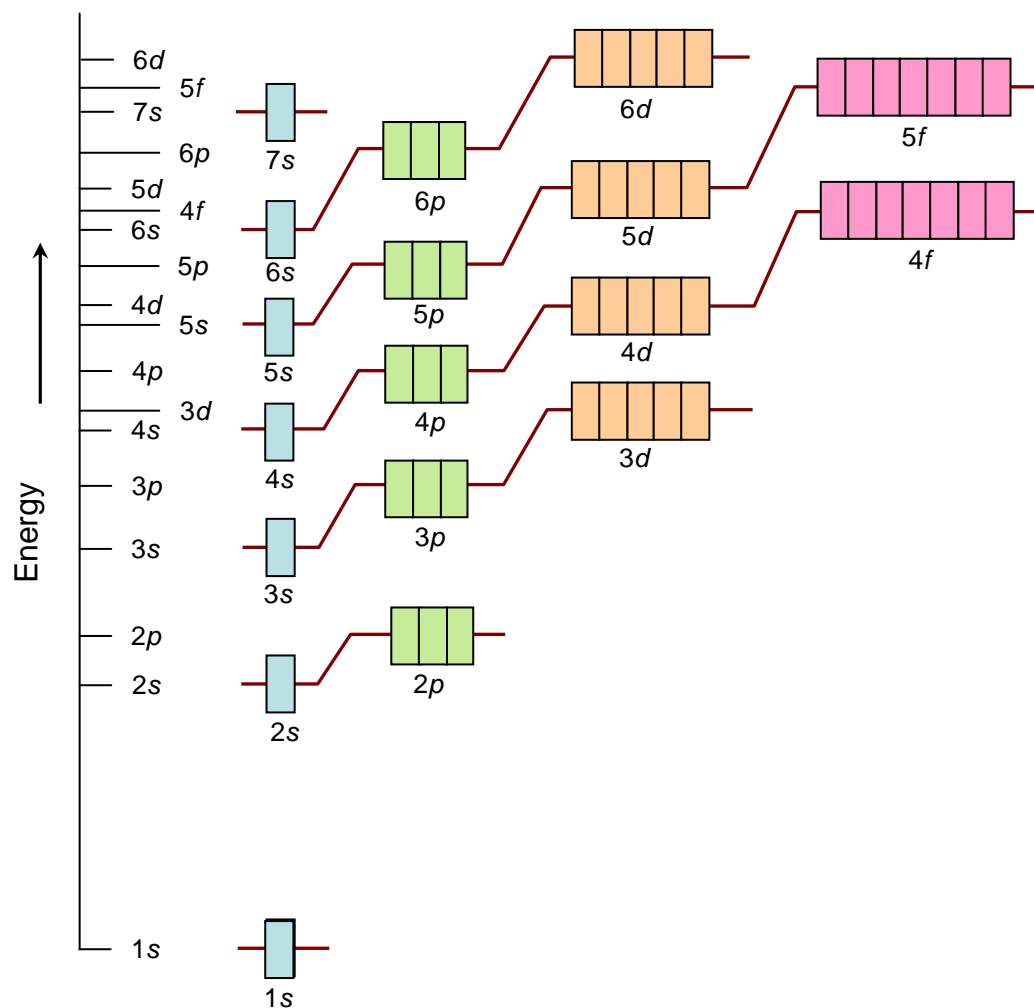
- **Pauli Exclusion Principle**
  - Each orbital can hold TWO electrons with opposite spins.



# General Rules

## Aufbau Principle

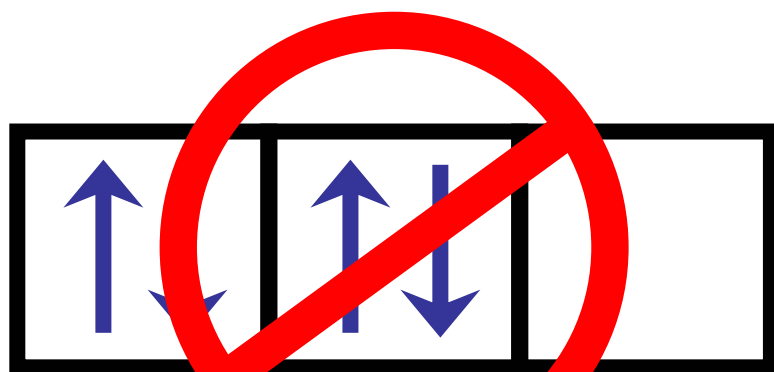
- Electrons fill the lowest energy orbitals first.
- “Lazy Tenant Rule”



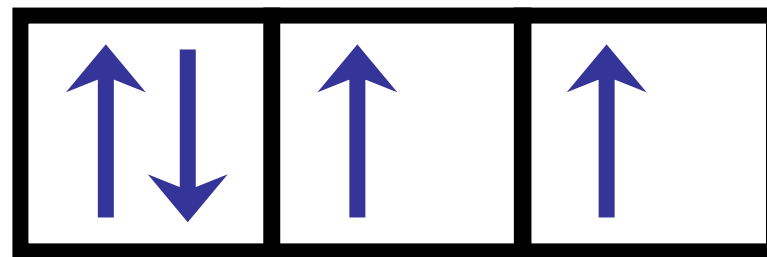
# General Rules

- Hund's Rule

- Within a sublevel, place one electron per orbital before pairing them.
- “Empty Bus Seat Rule”

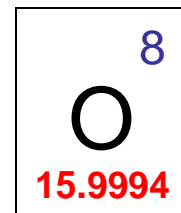


WRONG

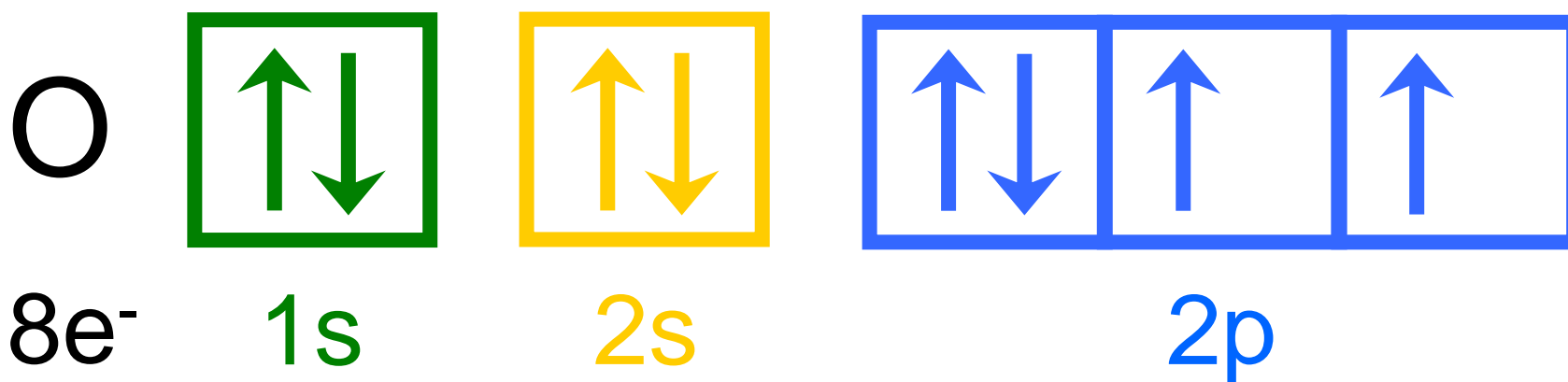


RIGHT

# Notation



- Orbital Diagram



- Electron Configuration



16
S
32.066

# Notation

- Longhand Configuration



- Shorthand Configuration



# Periodic Patterns

The diagram illustrates the periodic table with the following orbital filling order:

- Yellow (s-orbitals):** 1s, 2s, 3s, 4s, 5s, 6s, 7s.
- Green (d-orbitals):** 3d, 4d, 5d, 6d.
- Orange (p-orbitals):** 2p, 3p, 4p, 5p, 6p, 7p.
- Light Blue (f-orbitals):** 4f, 5f.

The principal quantum number  $n$  is indicated on the left side of the table. The filling order follows the Aufbau principle, with orbitals filled in order of increasing energy. The diagram shows that for a given  $n$ , the  $(n-1)d$  orbitals are filled before the  $np$  orbitals, and the  $(n-2)f$  orbitals are filled before the  $(n-1)d$  orbitals.

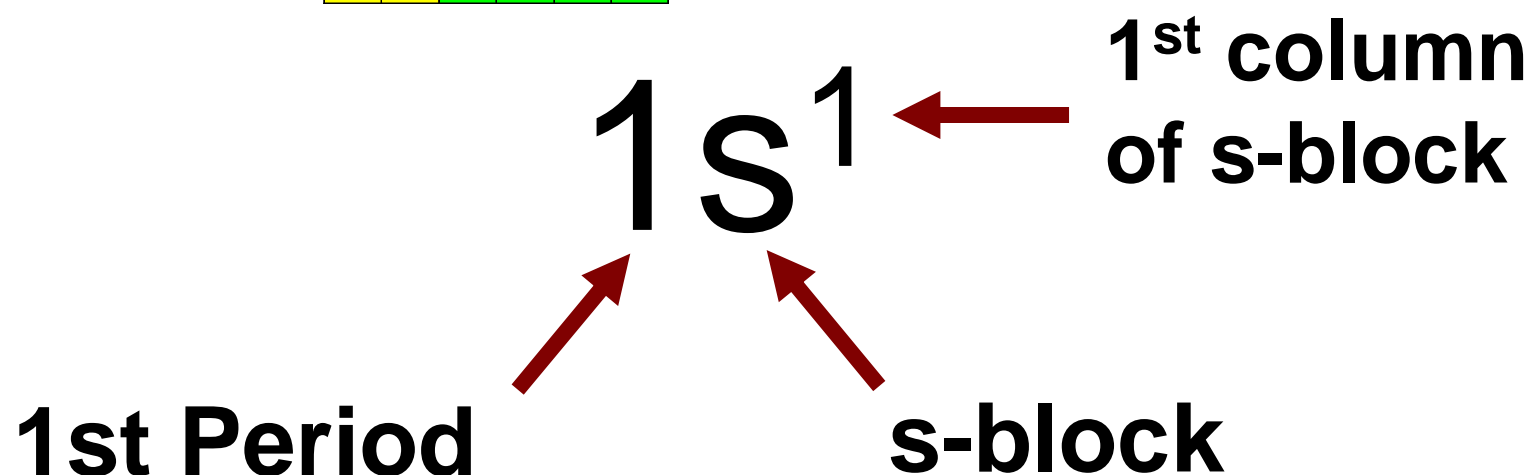
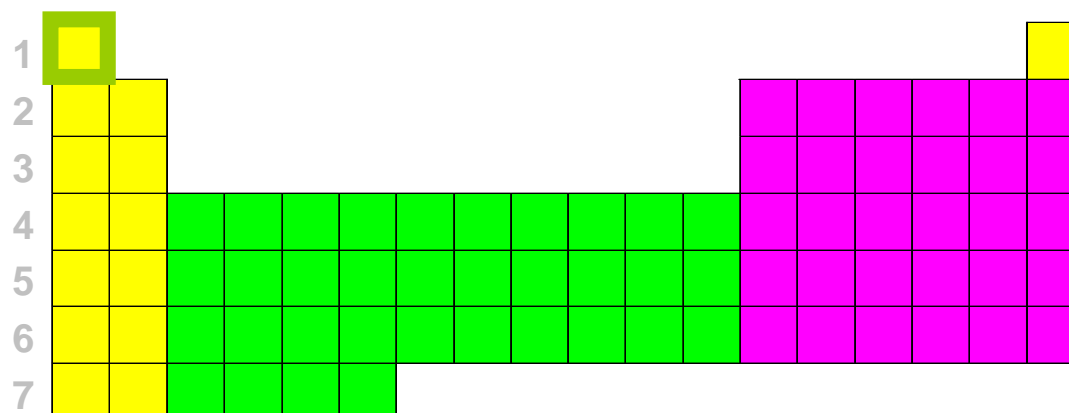
# Periodic Patterns

- **Period #**
  - energy level (subtract for d & f)
- **A/B Group #**
  - total # of valence  $e^-$
- **Column within sublevel block**
  - # of  $e^-$  in sublevel



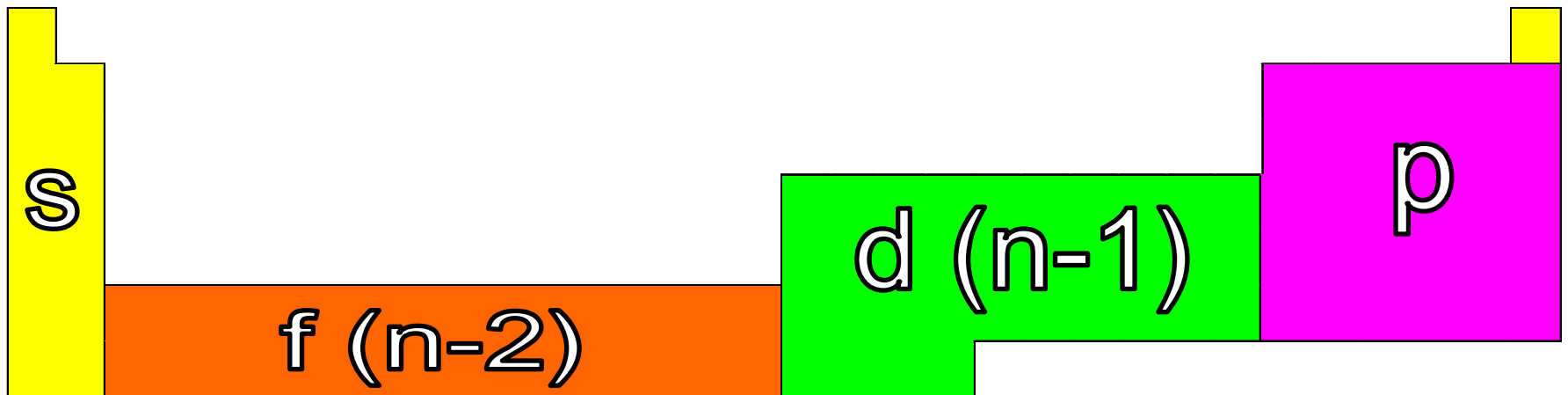
# Periodic Patterns

- **Example - Hydrogen**



# Periodic Patterns

- **Shorthand Configuration**
  - **Core electrons:**
    - Go up one row and over to the Noble Gas.
  - **Valence electrons:**
    - On the next row, fill in the # of  $e^-$  in each sublevel.

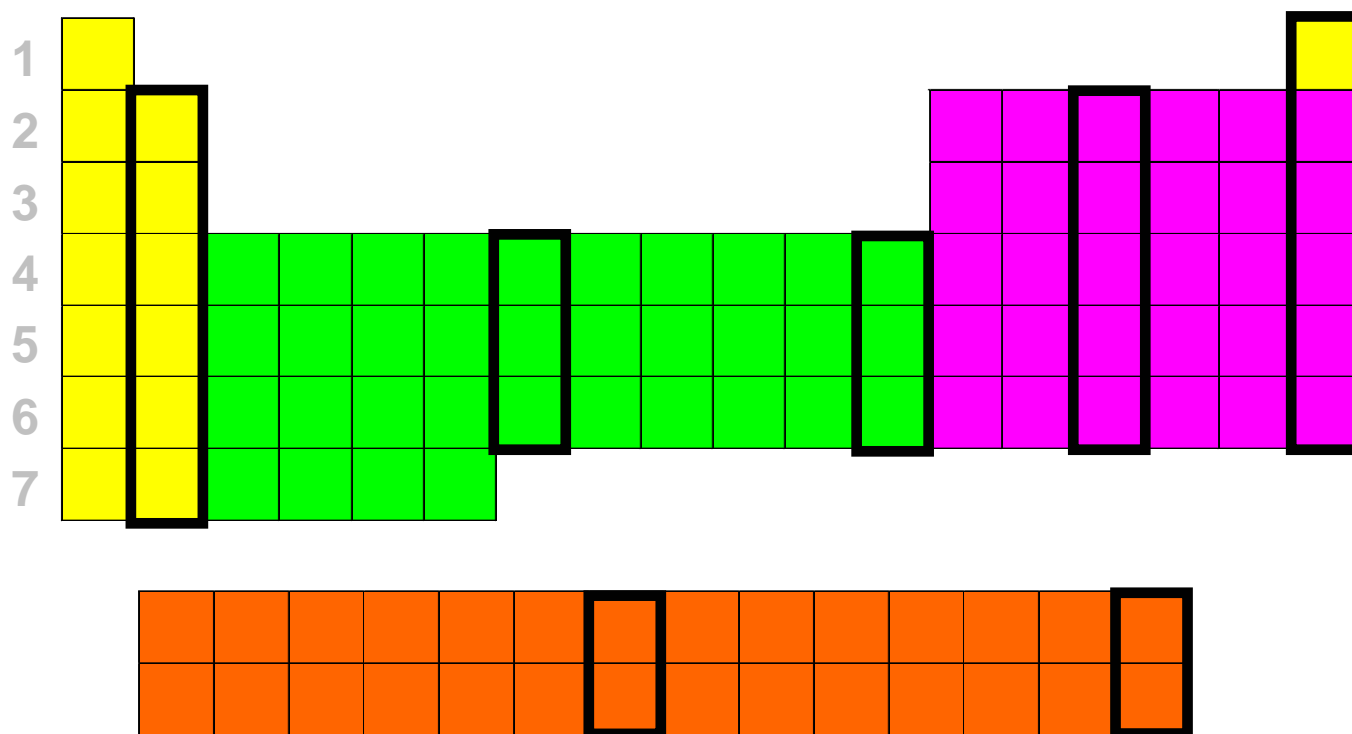


- 
- A 7x10 grid diagram illustrating a path. The grid is divided into three main colored regions: yellow (top-left), green (bottom-left), and magenta (right). The yellow region consists of a 3x2 block at the top-left and a 2x2 block at the bottom-left. The green region consists of a 4x4 block in the middle-left and a 3x4 block at the bottom-left. The magenta region consists of a 4x4 block in the middle-right and a 3x4 block at the bottom-right. A path is shown starting from a yellow cell at (1,10), moving left to (1,9), then down to (2,9), then left to (2,8), then down to (3,8), then left to (3,7), then down to (4,7), then left to (4,6), then down to (5,6), then left to (5,5), then down to (6,5), then left to (6,4), then down to (7,4), then left to (7,3), then down to (8,3), then left to (8,2), then down to (9,2), then left to (9,1), then down to (10,1), then left to (10,0), then down to (11,0), then left to (11,1), then down to (12,1), then left to (12,2), then down to (13,2), then left to (13,3), then down to (14,3), then left to (14,4), then down to (15,4), then left to (15,5), then down to (16,5), then left to (16,6), then down to (17,6), then left to (17,7), then down to (18,7), then left to (18,8), then down to (19,8), then left to (19,9), then down to (20,9), then left to (20,10), then down to (21,10), then left to (21,11), then down to (22,11), then left to (22,12), then down to (23,12), then left to (23,13), then down to (24,13), then left to (24,14), then down to (25,14), then left to (25,15), then down to (26,15), then left to (26,16), then down to (27,16), then left to (27,17), then down to (28,17), then left to (28,18), then down to (29,18), then left to (29,19), then down to (30,19), then left to (30,20), then down to (31,20), then left to (31,21), then down to (32,21), then left to (32,22), then down to (33,22), then left to (33,23), then down to (34,23), then left to (34,24), then down to (35,24), then left to (35,25), then down to (36,25), then left to (36,26), then down to (37,26), then left to (37,27), then down to (38,27), then left to (38,28), then down to (39,28), then left to (39,29), then down to (40,29), then left to (40,30), then down to (41,30), then left to (41,31), then down to (42,31), then left to (42,32), then down to (43,32), then left to (43,33), then down to (44,33), then left to (44,34), then down to (45,34), then left to (45,35), then down to (46,35), then left to (46,36), then down to (47,36), then left to (47,37), then down to (48,37), then left to (48,38), then down to (49,38), then left to (49,39), then down to (50,39), then left to (50,40), then down to (51,40), then left to (51,41), then down to (52,41), then left to (52,42), then down to (53,42), then left to (53,43), then down to (54,43), then left to (54,44), then down to (55,44), then left to (55,45), then down to (56,45), then left to (56,46), then down to (57,46), then left to (57,47), then down to (58,47), then left to (58,48), then down to (59,48), then left to (59,49), then down to (60,49), then left to (60,50), then down to (61,50), then left to (61,51), then down to (62,51), then left to (62,52), then down to (63,52), then left to (63,53), then down to (64,53), then left to (64,54), then down to (65,54), then left to (65,55), then down to (66,55), then left to (66,56), then down to (67,56), then left to (67,57), then down to (68,57), then left to (68,58), then down to (69,58), then left to (69,59), then down to (70,59), then left to (70,60), then down to (71,60), then left to (71,61), then down to (72,61), then left to (72,62), then down to (73,62), then left to (73,63), then down to (74,63), then left to (74,64), then down to (75,64), then left to (75,65), then down to (76,65), then left to (76,66), then down to (77,66), then left to (77,67), then down to (78,67), then left to (78,68), then down to (79,68), then left to (79,69), then down to (80,69), then left to (80,70), then down to (81,70), then left to (81,71), then down to (82,71), then left to (82,72), then down to (83,72), then left to (83,73), then down to (84,73), then left to (84,74), then down to (85,74), then left to (85,75), then down to (86,75), then left to (86,76), then down to (87,76), then left to (87,77), then down to (88,77), then left to (88,78), then down to (89,78), then left to (89,79), then down to (90,79), then left to (90,80), then down to (91,80), then left to (91,81), then down 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(176,165), then left to (176,166), then down to (177,166), then left to (177,167), then down to (178,167), then left to (178,168), then down to (179,168), then left to (179,169), then down to (180,169), then left to (180,170), then down to (181,170), then left to (181,171), then down to (182,171), then left to (182,172), then down to (183,172), then left to (183,173), then down to (184,173), then left to (184,174), then down to (



# Stability

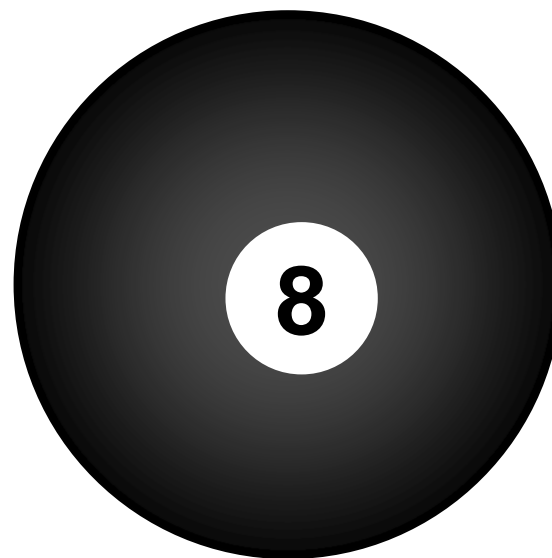
- Full energy level
- Full sublevel (s, p, d, f)
- Half-full sublevel



# The Octet Rule

*Atoms tend to gain, lose, or share electrons until they have eight valence electrons.*

This fills the valence shell and tends to give the atom the stability of the inert gasses.



ONLY **s**- and **p**-orbitals are valence electrons.

# Stability

- Electron Configuration Exceptions

- Copper

EXPECT:  $[\text{Ar}] 4s^2 3d^9$

ACTUALLY:  $[\text{Ar}] 4s^1 3d^{10}$

- Copper gains **stability** with a full d-sublevel. When copper loses one electron it becomes more stable with  $\text{Cu}^+ : [\text{Ar}] 3d^{10}$

# Stability

- Electron Configuration Exceptions
  - Chromium

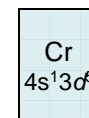
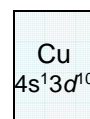
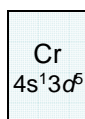
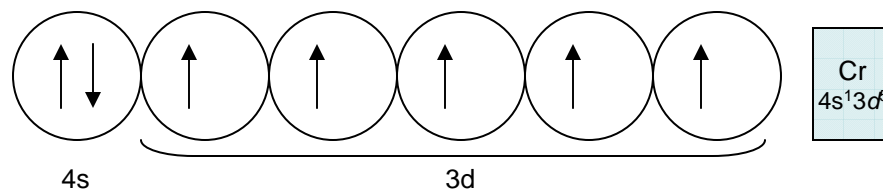
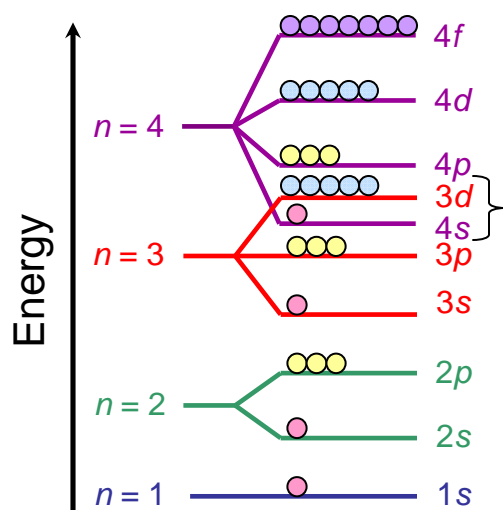
EXPECT:  $[\text{Ar}] 4s^2 3d^4$

ACTUALLY:  $[\text{Ar}] 4s^1 3d^5$

- Chromium gains **stability** with a half-full d-sublevel.

# Electron Filling in Periodic Table

	<b>s</b>												<b>p</b>						<b>s</b>
1																			
2																			
3																			
4	K 4s <sup>1</sup>	Ca 4s <sup>2</sup>	Sc 3d <sup>1</sup>	Ti 3d <sup>2</sup>	V 3d <sup>3</sup>	Cr 3d <sup>5</sup>	Mn 3d <sup>5</sup>	Fe 3d <sup>6</sup>	Co 3d <sup>7</sup>	Ni 3d <sup>8</sup>	Cu 3d <sup>10</sup>	Zn 3d <sup>10</sup>	Ga 4p <sup>1</sup>	Ge 4p <sup>2</sup>	As 4p <sup>3</sup>	Se 4p <sup>4</sup>	Br 4p <sup>5</sup>	Kr 4p <sup>6</sup>	

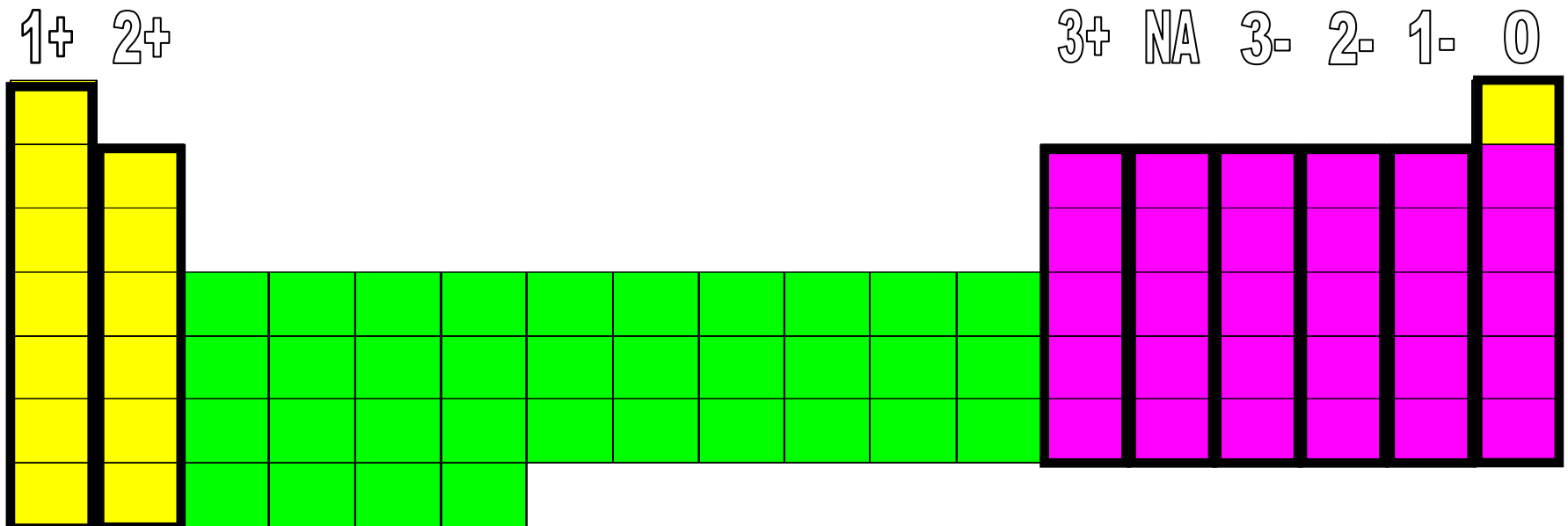




# Stability

- **Ion Formation**

- Atoms gain or lose electrons to become more stable.
- Isoelectronic with the Noble Gases.



# Stability

- **Ion Electron Configuration**

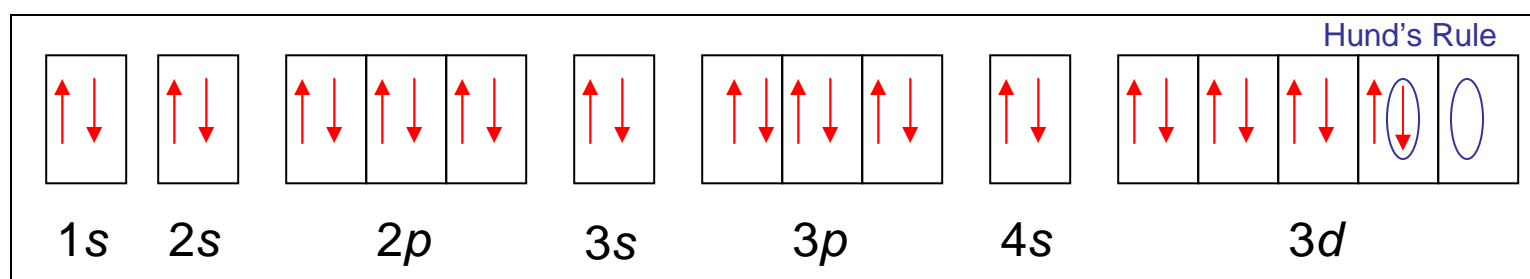
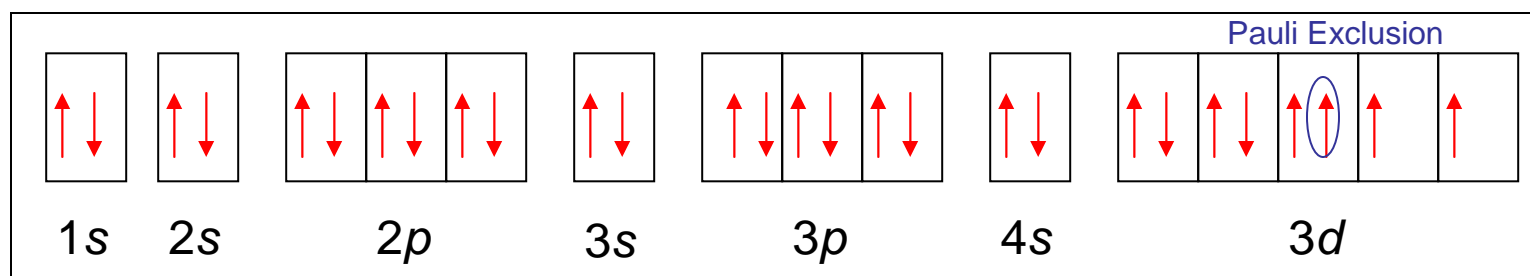
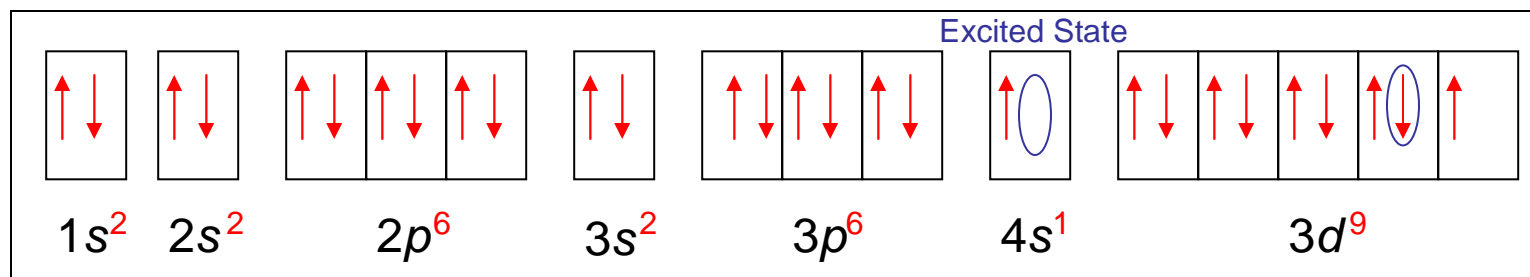
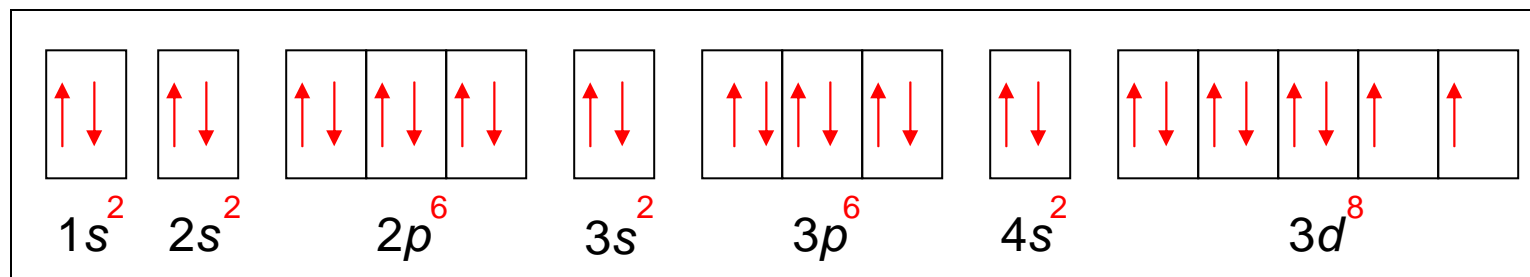
- Write the  $e^-$  configuration for the closest Noble Gas

- EX: Oxygen ion  $\rightarrow O^{2-} \equiv Ne$

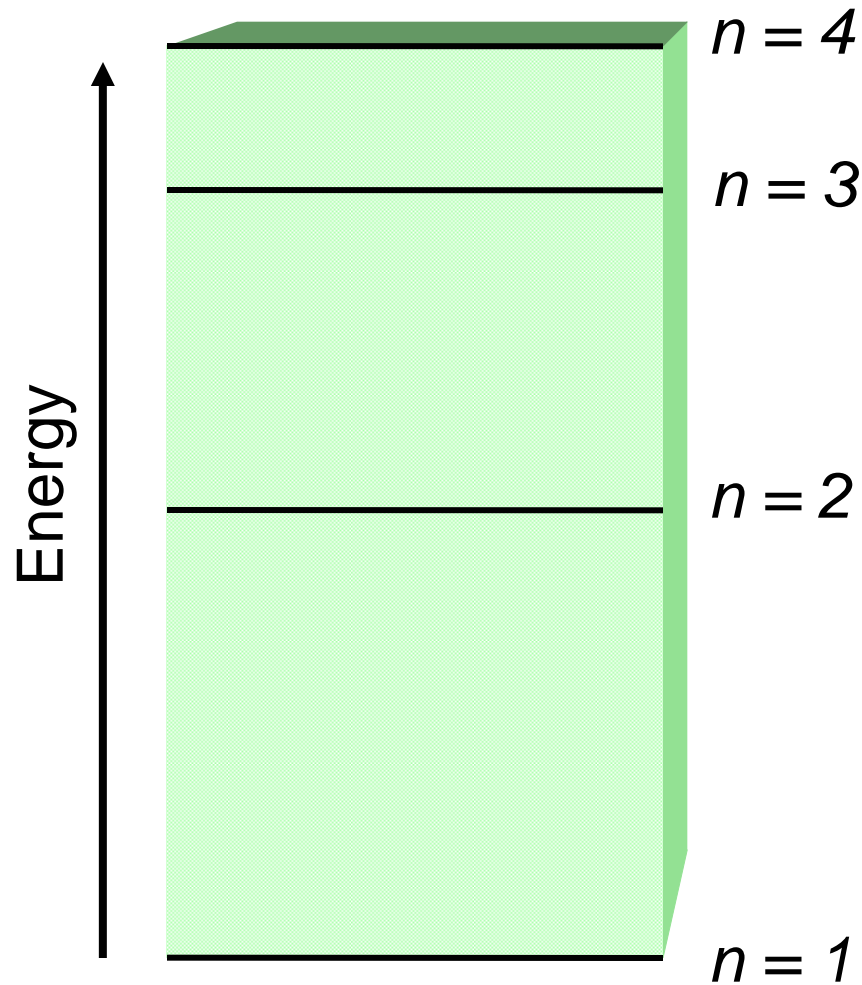


# Orbital Diagrams for Nickel

28  
Ni  
58.6934

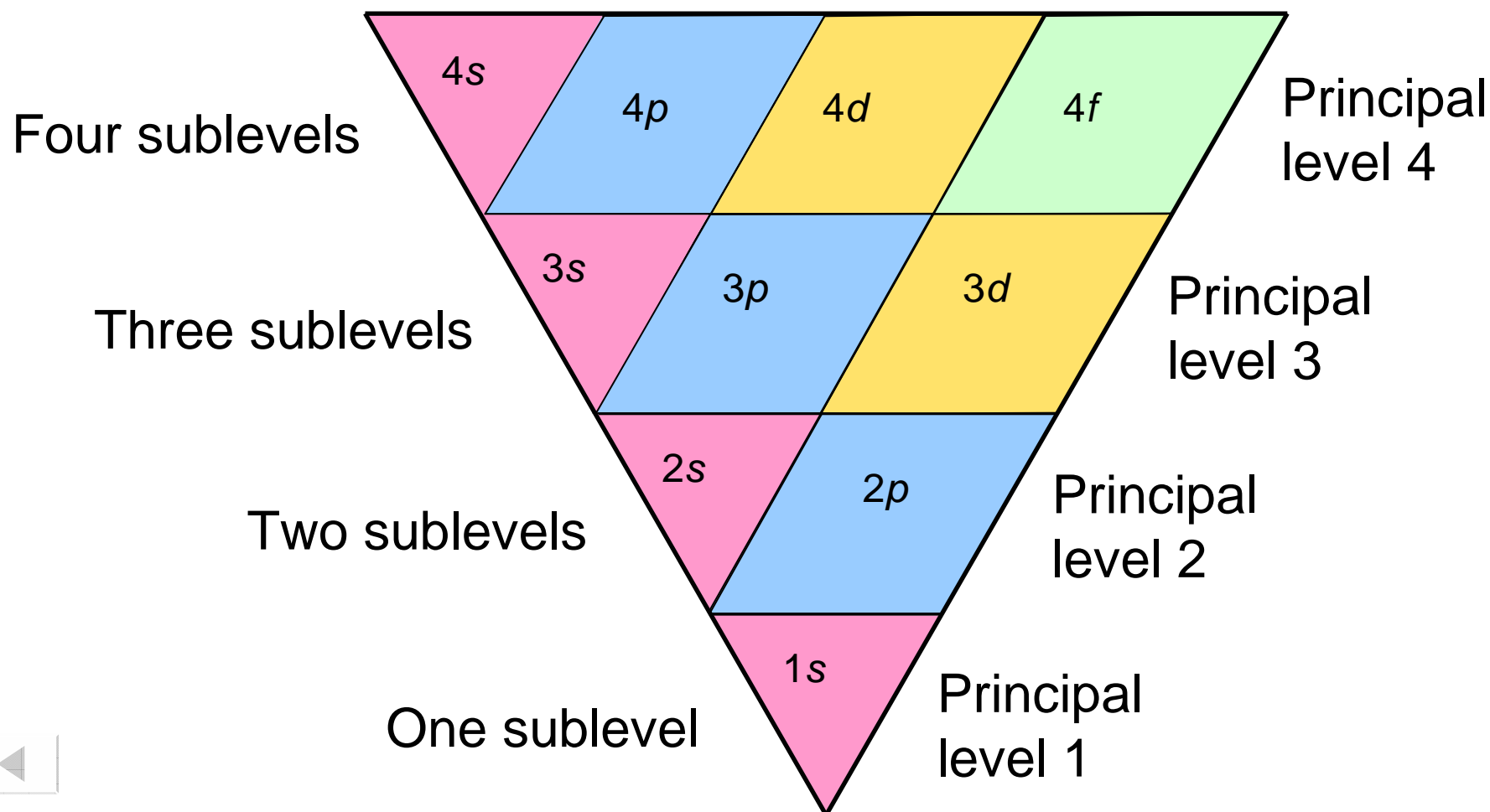


# First Four Energy Levels

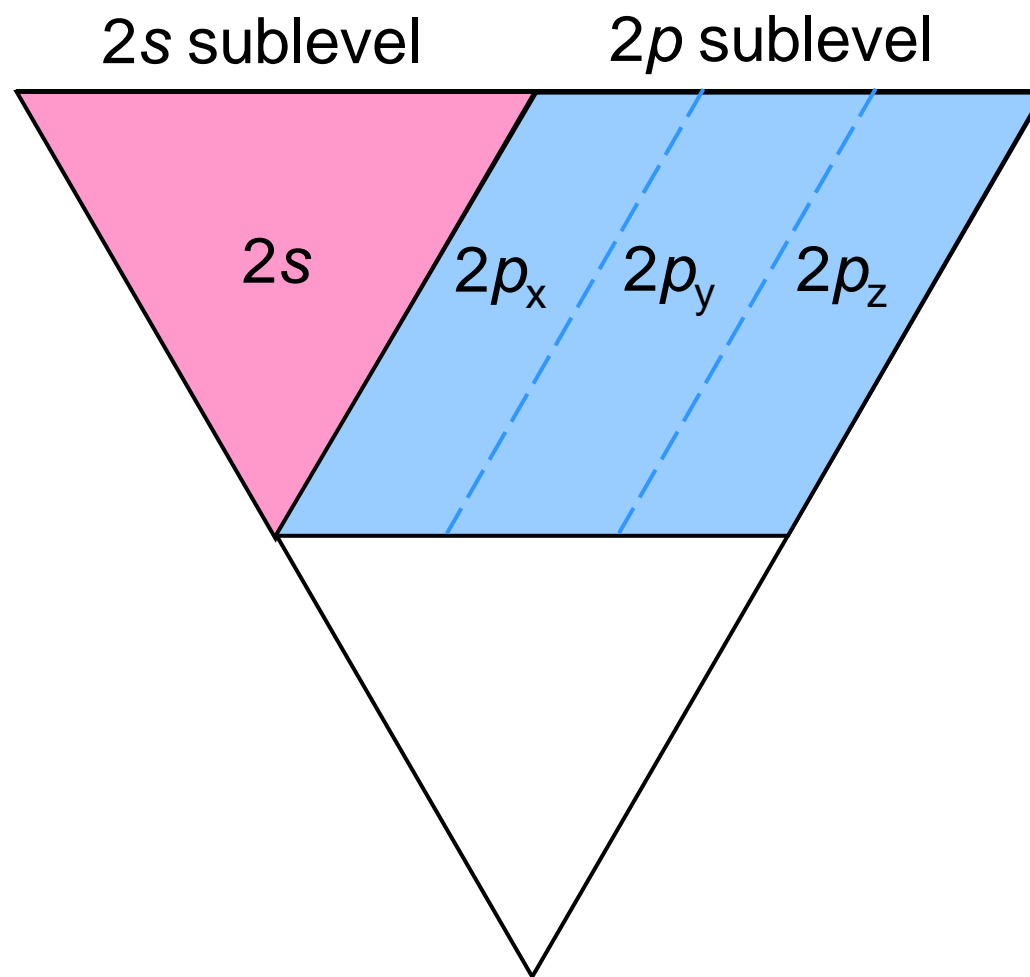


# Sublevels

Sublevel designation



# Principal Level 2 Divided



# Sublevels

